DOCUMENT RESUME

ED 294 902 TM 011 556

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TITLE Differing Policy Implications of Alternate Multiple Regressions Using the Same Set of Student Background Variables to Predict Academic Achievement.
PUB DATE Apr 88
NOTE 15p.; Paper presented at the Annual Meeting of the American Educational Research Association (New Orleans, LA, April 5-9, 1988).
PUB TYPE Speeches/Conference Papers (150) -- Reports - Evaluative/Feasibility (142)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Academic Achievement; *Educational Policy; Elementary Secondary Education; *Multiple Regression Analysis; Predictive Measurement; *Predictor Variables; Statistical Analysis; *Student Characteristics

ABSTRACT

Actual data sets were used to illustrate how substantially different conclusions and implications can be drawn from alternate multiple regressions predicting academic achievement from the same set of variables measuring student background. Variables assessing students' socioeconomic status and geographic mobility, used to predict reading and math achievement at 100 elementary schools, were interpreted for divergent conclusions about changes needed in schools. A second example showed differing interpretations of high school success, using 29 high schools. A third example considered dropout rates in over 300 elementary schools in a big city school district to support differing conclusions. Among the implications of the study are that statistics and their interpretation must take curvilinear relationships into account; that the influence of atypical schools should be considered; and that care should be exercised in selecting dependent variables. (SLD)

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Differing Policy Implications of Alternate Multiple Regressions Using the Same Set of Student Background Variables to Predict Academic Achievement

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Paper presented at the annual meeting of the American Educational Research Association, April 1988.

TM 011 556

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Differing Policy Implications of Alternate Multiple Regressions Using the Same Set of Student Background Variables to Predict Academic Achievement

The purpose of this paper is to utilize actual data sets in illustrating how substantially and sometimes radically different conclusions and implications can be drawn from alternate multiple regressions predicting academic achievement from the same set of variables measuring student background.

The first example begins with a regression using variables assessing students' socioeconomic status and geographic mobility to predict average reading and math achievement (combined as one variable) at 100 elementary schools in a central-city school district. The two predictors accounted for only 23 percent of the achievement variance. However, the relationship between the predictor variables and the dependent variable was highly curvilinear, and logging the two predictors increased the R^2 to .30.

In addition, the investigators believed that elementary math scores are much less predictable from students' background than are reading scores, because math at the elementary level deals primarily with drill on simple mechanical skills that poverty students frequently master at a high level, while they are falling behind on conceptual skills that are not being tested or stressed in instruction. Separating reading and math scores and using the former as the dependent variable increased the R^2 to .53.

The first R^2 of .23 could be (and actually was used) by some observers to support the conclusion that elementary schools in the district studied were extremely successful in overcoming students' learning problems associated with disadvantaged background. The third R^2 of .53

indicates that the schools studied are not all that successful in this regard.

Those reaching the first conclusion further concluded that major (and expensive) changes probably were not required to improve the achievement of students in low-achieving schools. Those accepting the latter conclusion argued that large increases in funding, desegregation, and other substantial reforms might be necessary to raise achievement substantially.

The second example begins with a regression in which information on students' socioeconomic status and race (separate variables) is used to predict average reading and math achievement (combined as one variable) for a group of 29 high schools in one metropolitan area. School socioeconomic status was portrayed by the percentage of students low in socioeconomic status as measured by eligibility for subsidized lunch or AFDC. The adjusted R^2 was .71. However, the relationship between achievement and socioeconomic status was highly curvilinear, and logging of the socioeconomic status variable increased the R^2 to .79. When three magnet high schools enrolling atypical groups of students were then removed from the analysis, the R^2 further increased to .95. As shown in Figure 1, predicted scores using the logged, socioeconomic variable and race showed a close-to-perfect relationship with the actual scores. The first analysis implies that high schools in the sample are much more potent in overcoming the learning handicaps of disadvantaged students than does the second or third analysis.

The strongly curvilinear nature of the relationships between the socioeconomic status variables and the criterion in both examples is particularly important in terms of policy implications. For both data sets,

there was a linear relationship between socioeconomic status and poverty until one reached a poverty "threshold" point beyond which schools were low in achievement but little or no relationship exists between status and achievement. For example, among the 100 elementary schools in the first example described above, all but one of the 35 which had more than 58 percent of their students eligible for subsidized lunch had median vocabulary scores far below the national average of 50; the one maverick in this group was slightly below 50 (see Figure 2). This pattern suggests that schools that exceed some critical proportion in poverty enrollment do not function adequately and radical steps must be taken to improve their achievement. The initial regressions not only had low explanatory power in part because they ignored curvilinear relationships, but also thereby ignored important phenomena that generated the patterns found in the data.

The third example which we will review in this paper is from a report predicting dropout rates in a big city school district from data on more than three hundred elementary schools which students had attended before they went on to graduate from or drop out of high school. The study reported that there is a "strong, positive" correlation of .47 between the percent of overage students in elementary schools and the subsequent dropout rate of their graduates. The major cause of students' overage status in elementary schools is retention in grade due to low achievement and other factors. After the authors controlled for percent of students below the national average in reading and found that percent overage still correlated at .30 with dropout rates, they concluded that their data supported the generalization that "retention increases eventual dropout rates."

A plot of the data which produced the correlation of .47 is shown in Figure 3. (The actual correlation is only .45 because we removed several schools with implausible data from the analysis). For most of the distribution, it is unclear that a strong correlation is present linking percent overage to dropout rate. Schools with percent overage scores ranging from about thirty to sixty percent have a higher dropout rate on the average than those with less than thirty percent overage, but much of the .47 correlation clearly is generated by the seven schools with more than 62 percent of their students overage. When we examined the data and the report in more detail, we found that all seven of these schools are "vocational centers" in which enrollment consists of overage students whose low achievement and/or behavior problems had resulted in their diversion from regular high schools. All of these vocational centers had subsequent dropout rates close to or above sixty percent.

While it is clear that attendance of overage students at the vocational centers did not result in high eventual school completion rates, it is not clear that overage status and dropping out are substantially or independently related in the population of elementary schools in the study as a whole. The apparent fact that many low achievers are retained in grade and later attend a relatively small number of vocational centers before dropping out of the system does not necessarily mean that retention is independently associated with dropping out on a systemwide basis.

To further examine this relationship, we excluded the seven schools with more than 62 percent overage students, and found that the correlation between percent overage and dropout rate was only .32. Controlling for percent below normal in reading, the partial correlation

fell to .16. (All variables in the partial correlation analyses were logged to take account of the curvilinear patterns that were present, as shown in Figure 3.) Adding controls for the percentage of low income students and the percentage of Hispanic students (for whom dropout rates are known to be higher than those for black or white students), the partial correlation was further reduced to .11. Thus after the seven atypical vocational centers are eliminated from the data set and appropriate variables are controlled, there is almost no relationship between percent overage and dropping out. Low income students, low achieving students, and Hispanic students are more likely to be retained in grade and later drop out of school than are white or black students who are higher in social class and reading achievement, but retention does not appear to increase the dropout rate independently after taking account of the prior variables.

In addition, we computed the statistics separately for the fifteen elementary schools that had more than 75 percent Hispanic enrollment. This analysis showed that there was a negative correlation of .32 ($p = .12$) between percent overage and subsequent dropout rates. Removing one outlier from the analysis, the correlation increased to -.50, $p = .03$. For these fourteen schools, the higher the percent overage, the lower the dropout rate. One perhaps might argue that retaining students reduces dropout rates by giving teachers more chance to raise their achievement, moderate their alienation, and/or reduce their experience of failure in the classroom. However, we do view this argument as necessarily receiving support from the data herein, because the sample of fourteen is too small to allow for control of variables such as reading achievement, and in any case these type of data probably are not very suitable for assessing the effects of retention in grade.

It should be emphasized that school-level information such as is used in the preceding analysis may not provide the best data for determining whether a policy of retaining students is likely to increase the dropout rate. Data on the social and educational background of individual students and their retention history might well support a different conclusion. To assess policy effects and implications, it would be desirable to conduct a longitudinal experiment to compare subsequent dropout rates of retention-eligible students (using specific and defensible criteria) who were randomly assigned to retention and non-retention treatments. Ideally, both treatments should provide effective instruction designed to overcome low achievement, behavioral alienation, and other problems associated with retention in public schools. Perhaps one could then begin to reach a defensible conclusion regarding the utility of retention/promotion practices. Cross-sectional multivariate analysis which ignores important phenomena in a data set does not seem to be of much help in reaching such a conclusion.

It is apparent from the preceding analyses that multiple regression and other multivariate techniques can be easily misused to arrive at faulty policy conclusions. It also is apparent that researchers frequently can manipulate a data set to draw vastly different conclusions. This conclusion is widely understood among researchers. The purpose of the present paper has been to provide concrete recent illustrations of questionable regression analysis involving the relationships among student background and school effectiveness variables. Among the technical implications one can draw from our illustrations are the following:

1. Statistics utilized and their interpretation should take account of curvilinear relationships.
2. Attention should be given to the potentially-potent influence of a few atypical schools before drawing conclusions intended to apply to the entire sample or population.
3. Care should be exercised in selecting dependent variables. In particular, scores on achievement may be more meaningful in upper grades than in lower grades in which tests tend to reflect drill and practice, and math scores may be less meaningful than reading scores for much the same reason. Combining scores across grade levels or subject areas may result in failure to identify potentially-important relationships that are present in a data set.

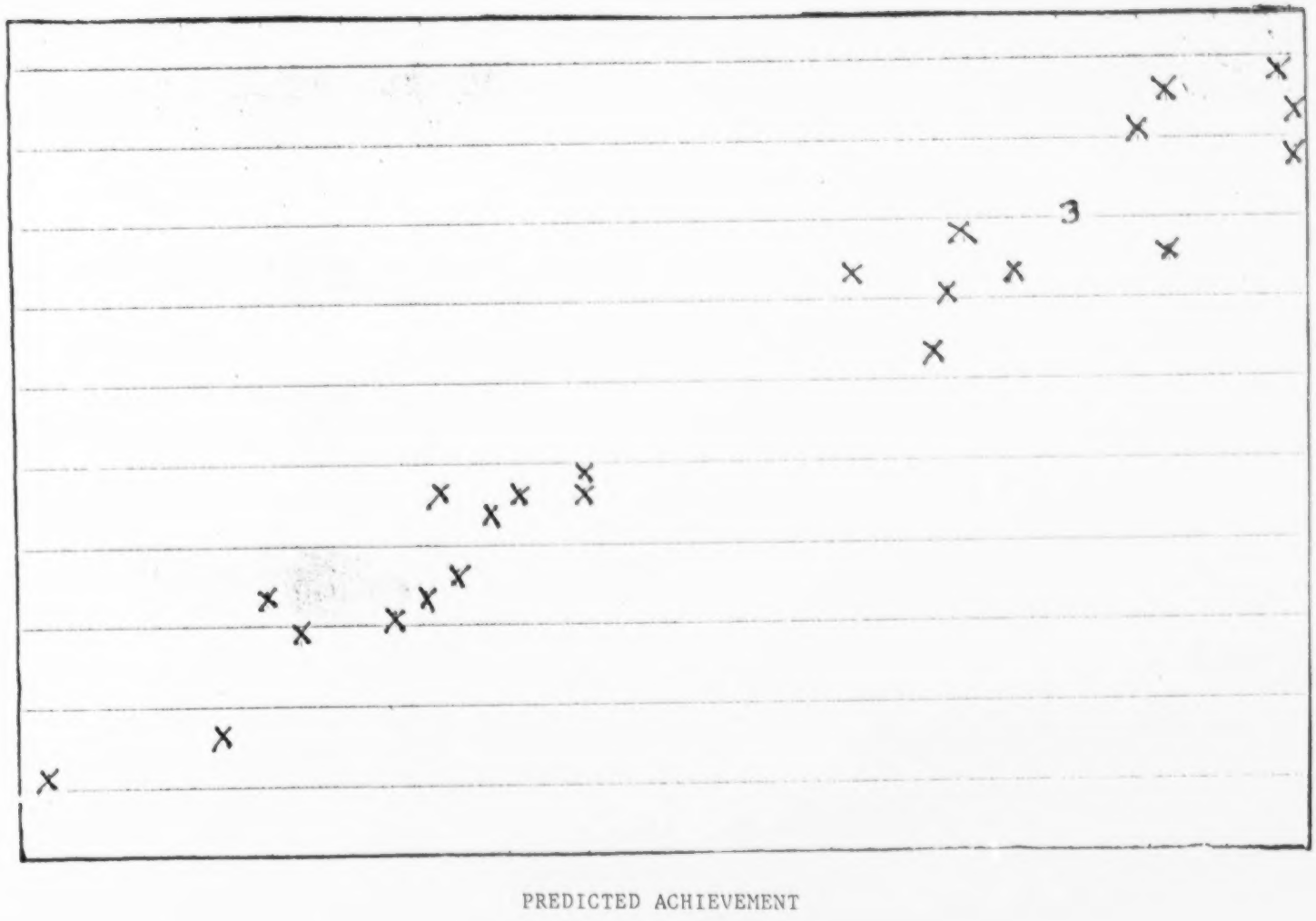

Figure 1. Actual and Predicted Achievement Based on Socioeconomic Status and Race, 26 High Schools

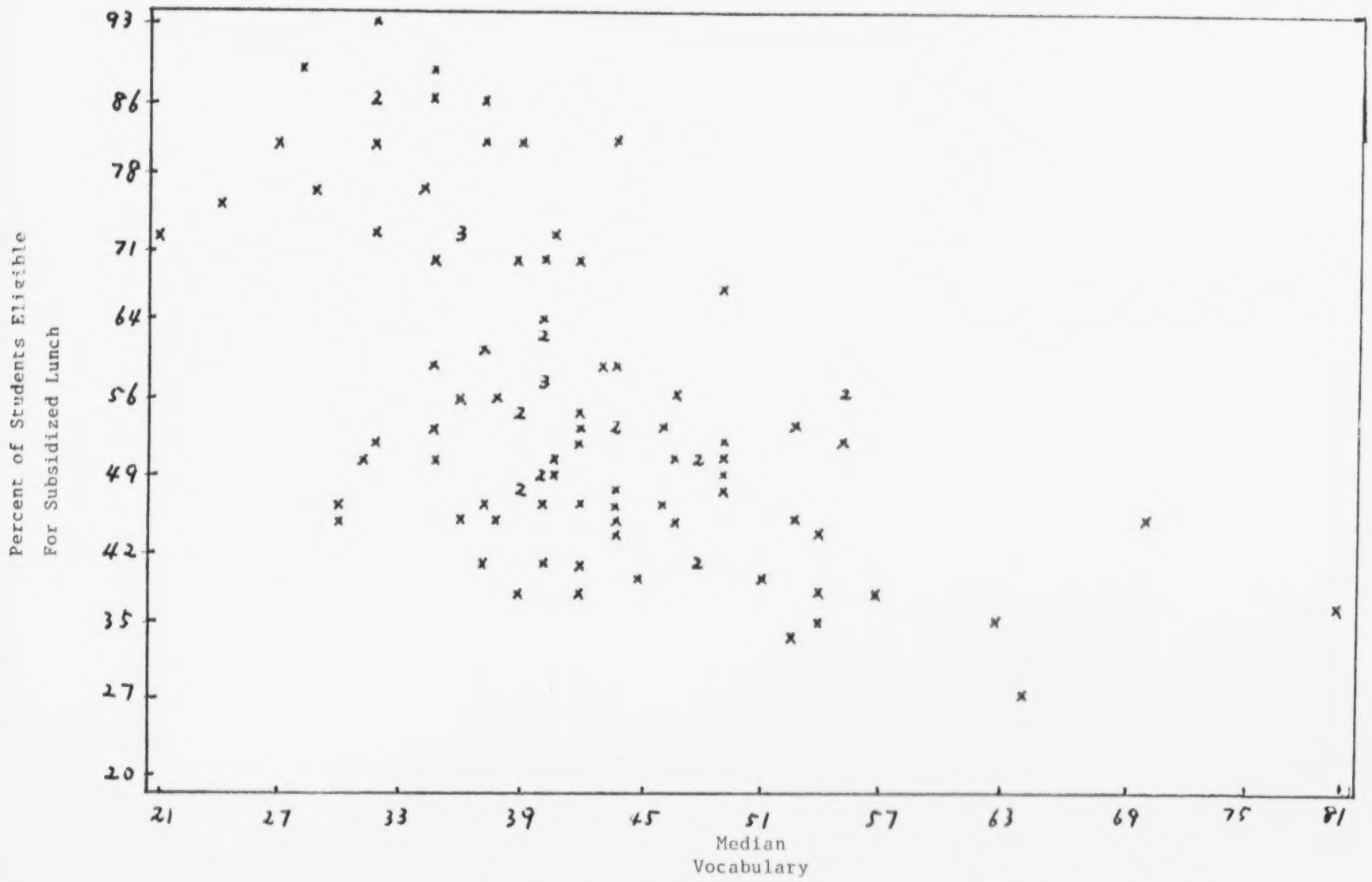

Figure 2: Median Vocabulary Score Plotted Against Percent of Students Eligible for Subsidized Lunch, 100 Elementary Schools

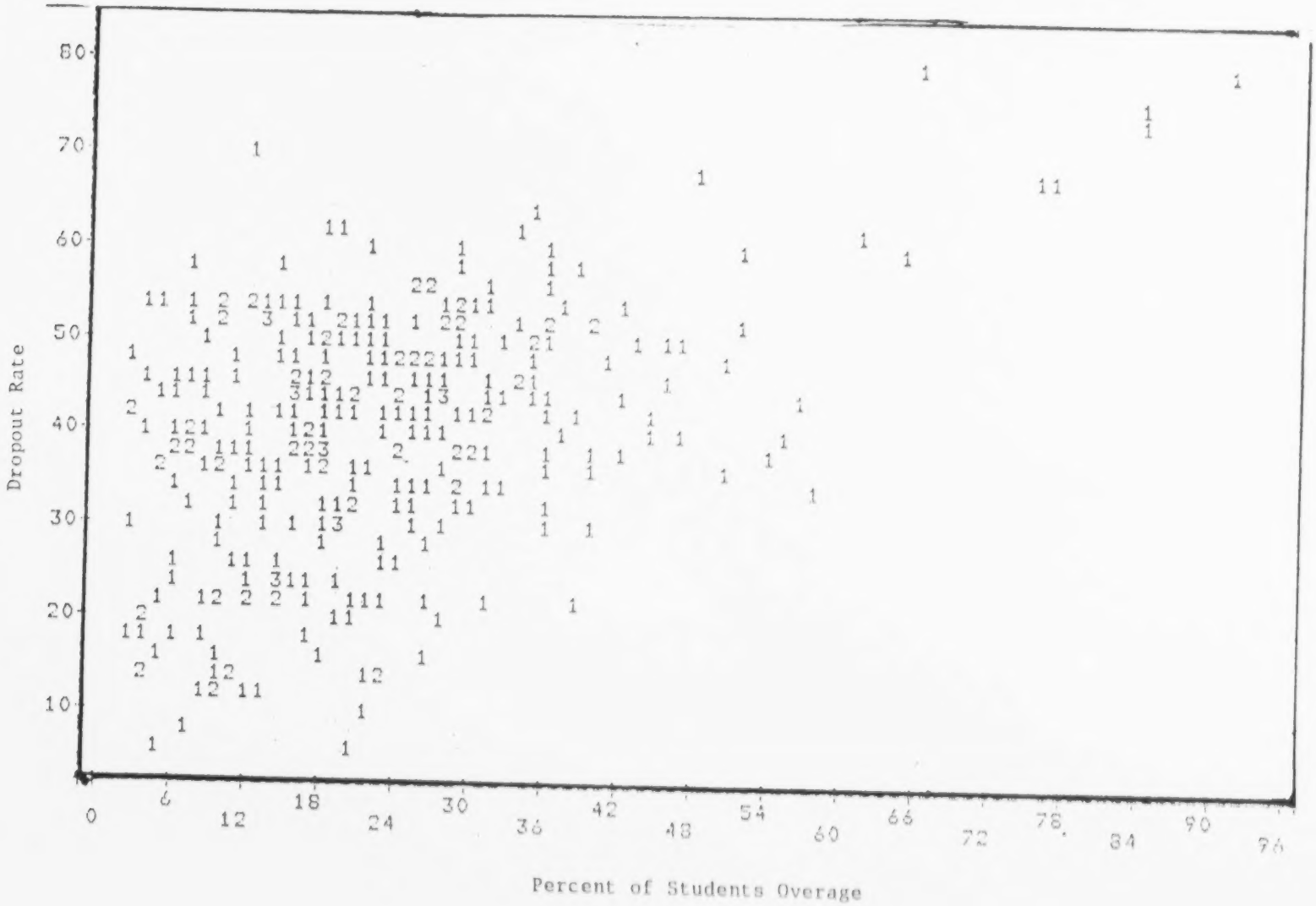

Figure 3. Percent of Students Overage Plotted Against Subsequent Dropout Rate, 333 Elementary Schools